

A New Marine Diatom *Cocconeis nagumoi* Hid. Suzuki (Bacillariophyceae) from Japan

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A new species of *Cocconeis*, *C. nagumoi* Hid. Suzuki, was found on a green seaweed collected from the Central Pacific coast of Japan. Morphology of the species was examined with light microscopy and scanning electron microscopy, and the details are described here. *Cocconeis nagumoi* is most similar to *C. shikinensis* Hid. Suzuki, but readily distinguished from it in having a broadly elliptic valve outline, a submarginal hyaline line on the raphid valve and a higher density of the striae on the both valves. The raphe valve of *C. nagumoi* is similar in structure to that of *C. scutellum* Ehrenberg var. *scutellum*. However, this new species is discriminated from it by having the striae consisted of several alveoli on the araphid valve.

Key words: *Cocconeis nagumoi*, Japan, marine diatom, new species.

Cocconeis Ehrenberg (Bacillariophyceae) is represented by ca. 280 species in the world (VanLandingham 1968) and inhabits through freshwater to brackish water often to marine. An unrecognized species of *Cocconeis* has been found growing on a green seaweed *Enteromorpha intestinalis* (L.) Nees from Tsurugizaki, Miura-shi, Kanagawa Pref. on the Central Pacific coast of Japan. Critical examination by light microscopy (LM) and scanning electron microscopy (SEM) and perusal of the literature reveal that this diatom represents a new species; we propose the name *C. nagumoi* Hid. Suzuki. Details of the morphological features are described here.

The material was treated using the bleaching method (Nagumo and Kobayasi 1990, Nagumo 1995, Osada and Nagumo 2001). The light and electron microscopy techniques were essentially the same as those used previously (cf. Suzuki et al. 2001a–d).

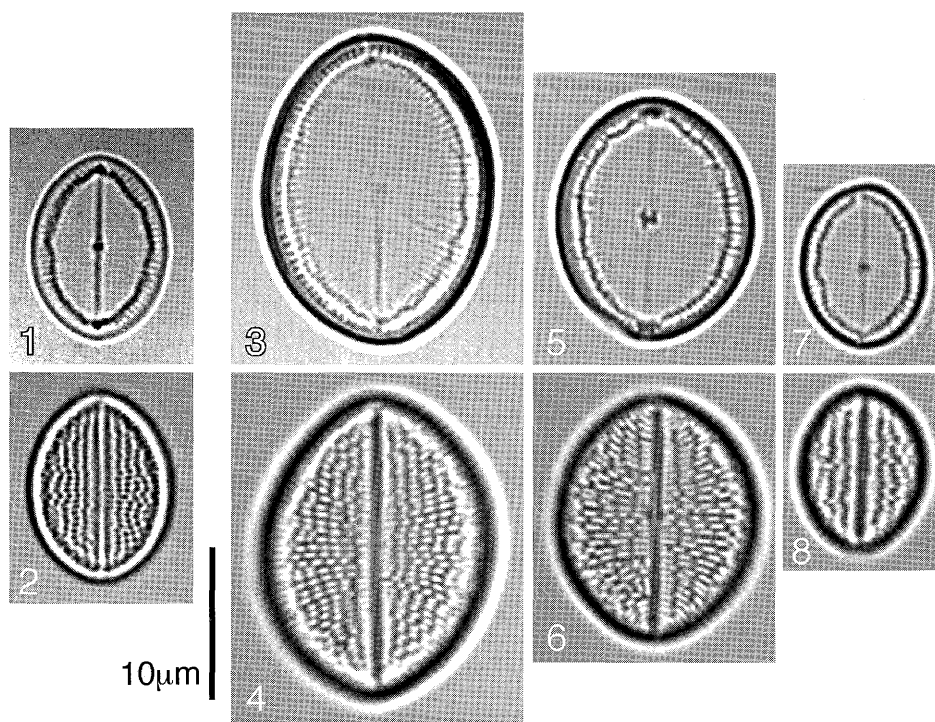
Specimens were examined using HITACHI S-5000 SEM.

Taxonomic treatment

Cocconeis nagumoi Hid. Suzuki, sp. nov.
[Figs. 1, 2]

Valvae parvulae, 8.0–20.5 μm longae, 6.5–15.5 μm latae, late ellipticae ad fere circulae. Valva cum raphe concava, raphe recta, area centrali elliptica vel orbiculari, striis uniseriatis, ad centrum parallelis rectisque, ad apices radiatis leniter curvatis, 32–36 in 10 μm , areolis circularibus. Valvocopula raphovalvae fimbriis. Valva sine raphe convexa, striis alveolatis, ad centrum parallelis rectisque, ad apices radiatis curvatisque, 30–34 in 10 μm , alveolo per foramen intra aperienti. Valvocopula areovalvae fimbriis.

TYPE: JAPAN; Honshu, Kanagawa Pref., Miura-shi, Tsurugizaki (35°08'N, 139°40'E), 17 Nov. 2002, H. Suzuki (Figs. 1, 2–holo-



Figs. 1–8. *Cocconeis nagumoi* Hid. Suzuki. Raphid valves (Figs. 1, 3, 5, 7) and araphid valves (Figs. 2, 4, 6, 8) of the same frustule. Figs. 1, 2. Holotype.

type).

Type slide: TNS-AL-53976.

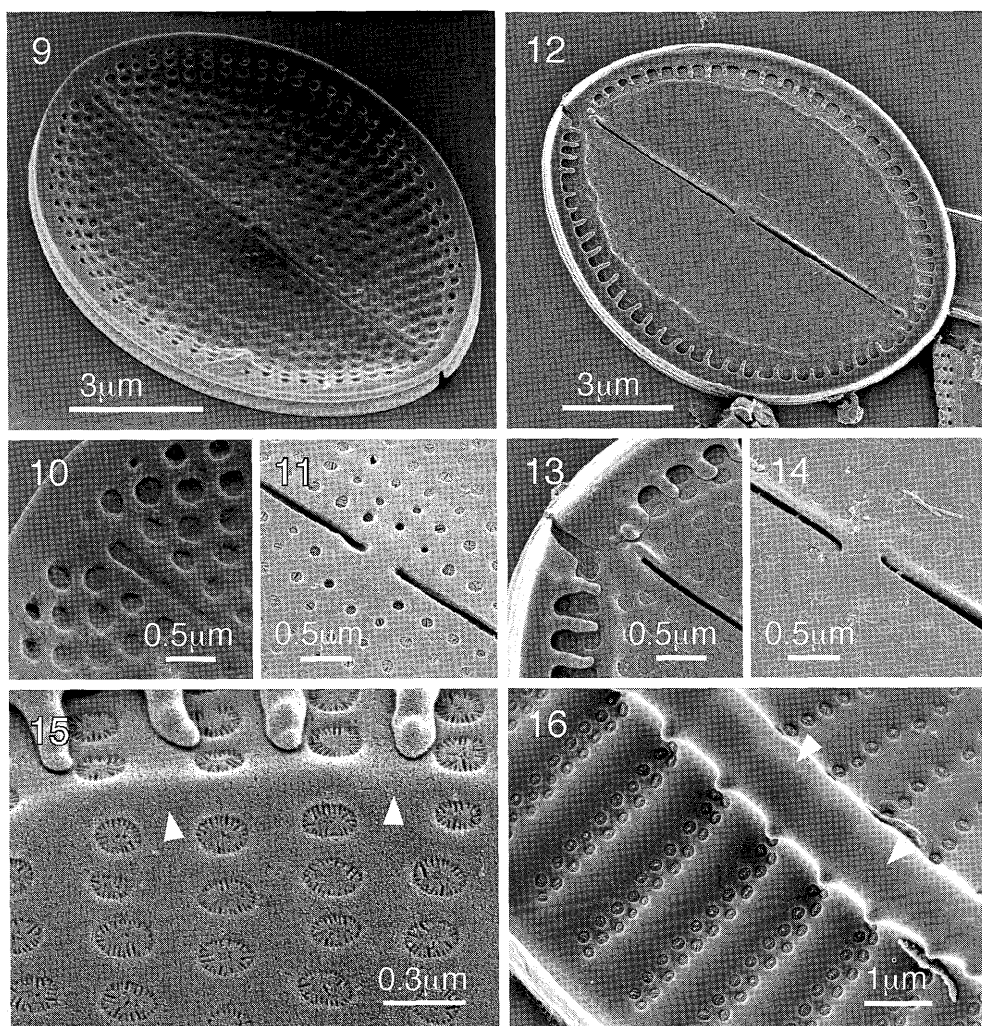
Type material: TNS-AL-53976. Epiphytic on *Enteromorpha intestinalis* (L.) Nees (Ulvaceae, Chlorophyceae).

Other specimens examined: JAPAN: Honshu; Kanagawa Pref., Yokosuka-shi, Sajima, Tenjinjima (35°15'N, 139°34'E), 22 May 2004, epiphytic on *Enteromorpha crinita* (Roth) Nees (Ulvaceae, Chlorophyceae), H. Suzuki MTUF-AL-HS0524. Ashigarashimo-gun, Manazuru-machi, Manazurumisaki, Mitsuishi (35°8'N, 139°9'E), 05 Feb. 2006, epiphytic on *Enteromorpha intestinalis* (L.) Nees (Ulvaceae, Chlorophyceae), H. Suzuki MTUF-AL-HS0629.

Etymology: The specific epithet is dedicated to Dr. Tamotsu Nagumo, Professor at the Department of Biology, the Nippon Dental University, in recognition of his significant contribution to taxonomic research in diatoms.

The valves are very small, 8.0–20.5 μm long, 6.5–15.5 μm wide, broadly elliptic to almost circular (Figs. 1–8). Stria densities at the center of valves are 32–36 in 10 μm on the raphid valve (RV) and 30–34 in 10 μm on the araphid valve (ARV).

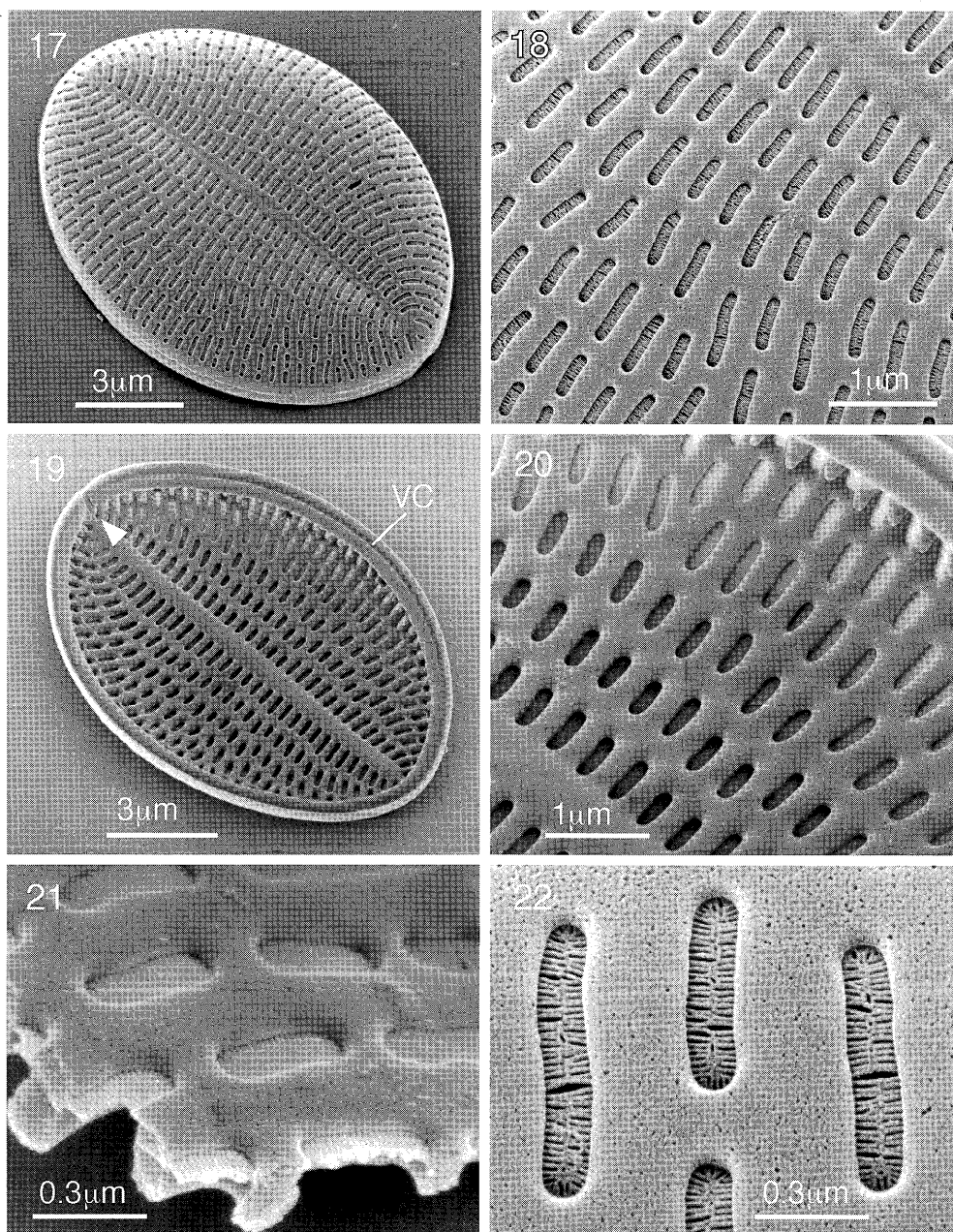
The valve face of the RV is slightly concave (Fig. 9). The raphe appears externally as a simple slit, which is straight (Fig. 9). The inner raphe fissures lie in a very narrow axial area (Fig. 12). Externally, the proximal raphe ends are coaxial (Fig. 11), but internally they are undilated and slightly deflected in opposite directions (Fig. 14). The distal raphe ends are dilated externally (Fig. 10), but terminate in diminutive helictoglossae internally (Fig. 13). The central area is very small and round (Fig. 11), appearing slightly raised internally (Fig. 14).



Figs. 9–15. *Cocconeis nagumoi* Hid. Suzuki. Raphid valves. Figs. 9–11. External views of the raphid valve. Fig. 9. Whole valve. Fig. 10. Distal raphe end in terminal area. Fig. 11. Proximal raphe ends in central area. Figs. 12–15. Internal views of the raphid valve. Fig. 12. Whole valve. Fig. 13. Diminutive helictoglossa in terminal area. Fig. 14. Proximal raphe ends in central area. Fig. 15. Internal views of the raphid valves with valvocopula. Arrowheads indicate a thickening that follows the valve outline. Fig. 16. *Cocconeis scutellum* Ehrenberg var. *scutellum*; Internal view of the raphid valve showing the marginal area. Arrowheads indicate a thickening that follows the valve outline.

The submarginal hyaline area is hardly recognizable on the external valve surface (Fig. 9). On the inside, however, the hyaline area is obvious (Figs. 1, 3, 5, 7) and coincides with a slight thickening that follows the valve outline (Figs. 12, 15). The striae

consist of small round areolae and are radiate and uniseriate (Fig. 9). The striae of *C. scutellum* Ehrenberg var. *scutellum*, having a submarginal thickened area, are uniseriate almost throughout the valve surface and biseriate only along the valve margin (Fig.



Figs. 17–22. *Cocconeis nagumoi* Hid. Suzuki. Araphid valves. Figs. 17, 18. External views of the araphid valve. Fig. 17. Whole valve. Fig. 18. Valve face. Figs. 19, 20. Internal views of the araphid valve with a valvocopula (VC). Fig. 19. Whole valve. Arrowhead indicates an opening of VC. Fig. 20. Valve face. Fig. 21. Alveoli occluded by hymenes located near the outer surface. Fig. 22. Hymenes with perforations in a parallel array.

16; Holmes et al. 1982, Romero 1996). Each areola is occluded by a hymen with linear perforations, which are radially arranged, with longer and shorter ones alternating (Fig. 15).

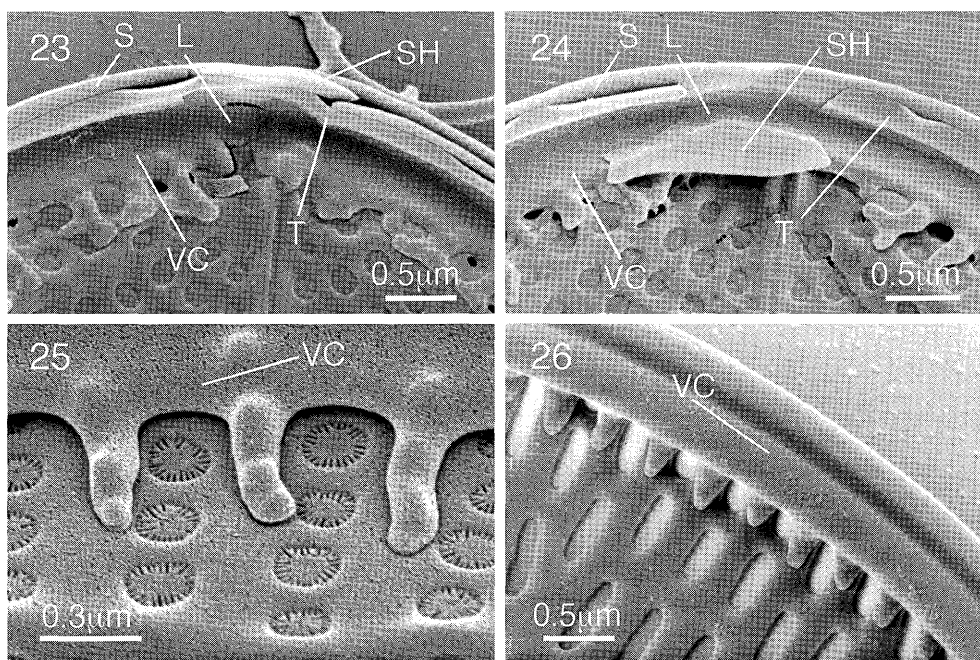
The ARV is convex overall and dome-shaped (Fig. 17). The axial area lies in a very narrow groove in the outer surface; it is straight (Fig. 17). No central area is present. The alveolate striae are interrupted by several slightly undulate, narrow hyaline spaces on both sides of the axial area (Figs. 17, 18), straight and slightly radiate in the center of the valve, changing to radiate and curved towards the apices. Each alveolus opens internally by means of a highly elliptical foramen (Figs. 19, 20). Due to the somewhat thicker internal silica layer, a clear image of the perforations in the hymen is visible only in broken valves (Fig. 21). And this alveolus is occluded by a hymen located near the outer surface (Fig. 21). Hymen perforations are arranged in a parallel array (Fig. 22; cf. Mann 1981). The alveolus structure of *C. nagumoi* is essentially the same as that of *C. pellucida* Grunow (Kobayasi and Nagumo 1985), *C. heteroidea* Hantzsch (Suzuki et al. 2001a), *C. shikimensis* Hid. Suzuki (Suzuki et al. 2001b), *C. convexa* Giffen (Suzuki et al. 2001c), and *C. pseudomarginata* Gregory var. *intermedia* Grunow (Suzuki et al. 2001d). The morphology of the internal areola opening of these taxa ranges from circular to elliptic while in *C. nagumoi* it is always highly elliptic.

The mature girdle of both valves of *C. nagumoi* consist of at least three girdle bands: a valvocopula (VC) and two bands. The morphology of VC is entirely different between both valves. The VC of RV is open at one pole of the cell and bears fimbriae, which is unornamented projections from the advalver margin (Figs. 12, 13, 25). The fimbriae are built up finger-like prolongations coinciding with each interstria, and do not reach a thickening that follows the valve

outline (Fig. 15, arrowheads). The fimbriae are similar to those in the RV of *C. shikimensis* Hid. Suzuki (2001b), but are not hammerhead as those of *C. scutellum* var. *scutellum* shown by Holmes et al. (1982) and Romero (1996), and of *C. sagaraensis* Hid. Suzuki (in Suzuki et al. 2005). The open ARV valvocopula also possesses fimbriae (Fig. 20). But, these are different in morphology from those occurring on the RV, are short and stout projections (Fig. 26). The second and third bands are narrower and thinner than the valvocopula, and are open at one pole of the cell (Figs. 23, 24). The both bands possess short bands with small ligulae (Figs. 23, 24), as *C. stauroneiformis* (Rabenhorst) Okuno (Suzuki and Nagumo 2003a).

The main morphological features of *C. nagumoi* are as follows: (i) the valves are very small, broadly elliptic to almost circular; (ii) the raphe on the RV is straight; (iii) a submarginal hyaline area coincides internally with a thickening that follows the valve outline; (iv) the RV striae consist of small, round areolae and are uniseriate; (v) the ARV surface is dome-shaped; (vi) the ARV striae consist of several alveoli; (vii) each alveolus opens internally by means of a highly elliptical foramen; (viii) the RV valvocopula has several finger-like fimbriae; and (ix) the ARV valvocopula also possesses fimbriae, which are a little shorter and stouter.

This species grows abundantly on *Enteromorpha* spp. in the tide pool in the intertidal upper zone (Suzuki 2005), and the following diatoms were found growing sympatrically; *Achnanthes brevipes* C. Agardh var. *intermedia* (Kützinger) P. T. Cleve, *A. grunowii* Toyoda & D. M. Williams, *Cocconeis scutellum* Ehrenberg var. *parva* (Grunow) Cleve, *Tabularia parva* (Kützinger) Williams & Round, etc. *C. nagumoi* was not recorded on the previous reseaches in the flora of the epiphytic diatoms (Takano 1962, Edsbadge 1966, Tanaka



Figs. 23–26. *Cocconeis nagumoi* Hid. Suzuki. Cingula. Figs. 23, 24. Valvocopula (VC), and the second (S) and the third (T) bands with a short band (SH) respectively of raphid valve. L: ligula. Fig. 24. Opposite pole. Fig. 25. Detail of the valvocopula (VC) and fimbriae of raphid valve. Fimbriae are built up by finger-like prolongations coinciding with each interstria. Fig. 26. Details of the valvocopula (VC) and fimbriae of araphid valve.

1984, Nagumo and Tanaka 1990, 1994, Suzuki et al. 1999, 2000, Suzuki and Kobayashi 2002, Suzuki and Nagumo 2003b, 2004).

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鈴木秀和, 田中次郎: 本邦沿岸からの海産珪藻の
1新種, *Cocconeis nagumoi* (珪藻綱)

神奈川県三浦市剣崎沿岸で採取したボウアオノリ *Enteromorpha intestinalis* (L.) Nees に着生していた新種 *Cocconeis nagumoi* Hid. Suzuki の光学顕微鏡および走査型電子顕微鏡による殻微細構造の観察結果を報告する。殻は小さく、幅の広い楕円形あるいは円形。縦溝殻: 殻面は凹状。殻縁近くには無紋域があり、内面で肥厚する。縦溝は直線状。条線は10 μm に32–36で、小さな円形の胞紋からなる。胞紋は、縁に沿って放射状に配列する短い穿孔を持つ薄皮により閉塞される。無縦溝殻: 殻面は凸状にふくらみ、ドーム形。条線は10 μm に30–34で、長胞構造をなす。殻の内面にはそれ

ぞれの長胞への扁平な楕円形の開口がある。長胞には平行配列の穿孔をもつ薄皮が殻の外側に近い位置に張る。半殻帯: 両殻とも少なくとも3枚の帯片からなる。接殻帯片は、両殻とも片端開放型、指状突起をもつが、無縦溝殻の方が短くしっかりしている。形態的には、本種の縦溝殻は *C. scutellum* Ehrenberg var. *scutellum* に、無縦溝殻は *C. shikinensis* Hid. Suzuki に似るが、*C. scutellum* var. *scutellum* の無縦溝殻の条線は長胞構造ではなく、また *C. shikinensis* の縦溝殻の縁辺部には肥厚する無紋域を欠くことにより異なる。

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